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BUDGETING FOR TECHNOLOGICAL RISK IN
PROCUREMENT

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ABSTRACT

This paper presents the results of the Army's effort to quantify risk and to budget funds for the technological uncertainty in the procurement of weapons systems. This effort is known as Total Risk Assessing Cost Estimate for Production (TRACE-P). This paper describes the model and methodology used to quantify this uncertainty. It discusses implementation of the system and the results experienced to date.

BACKGROUND

The US Army Materiel Development and Readiness Command (DARCOM) sets challenging goals for the development and procurement of major weapons systems. These success-oriented programs entail risk and the seemingly inevitable occurrence of unfunded contingencies. It is no easy task to retain our optimistic funding, schedule, and performance goals while presenting a fully executable program with adequate funding for technological risks. Requests for funding of contingencies must survive the budget process. What is required is a systematic, organized, credible approach to provide realistic cost estimates. It should provide assurance that funds for technological risk are adequate but not excessive. To address the problem the Army developed the TRACE concept.

INITIATION OF THE TRACE CONCEPT

The original concept to budget for the uncertainty in research and development (R&D) was initiated by the Army in 1974 under the guidance of Mr. Norman A. Augustine, then Assistant Secretary of the Army for Research and Development¹. A good overview of this Total Risk Assessing Cost Estimate (TRACE) concept is found in a recent paper by LTC John D. Edgar, Defense Systems Management College². Extension of the concept to

budgeting for the technological risk in production was approved on 30 April 1981 by then Deputy Secretary of Defense Frank C. Carlucci³. This extension, known as TRACE-P, supports Carlucci initiatives 6 and 11:

Initiative No. 6: Budget to Most Likely Cost
Initiative No. 11: Budget Funds for
Technological Risk

Further, on 22 July 1981, the Vice Chief of Staff, Army, stated a decision to implement the concept of funding to cover uncertainties in production⁴. The Army Cost Discipline Advisory Committee monitors the progress of this and other high level initiatives.

DEVELOPMENT OF TRACE-P

Shortly after the Carlucci initiatives were promulgated, a test case for TRACE-P was performed on the Remotely Piloted Vehicle (RPV) by Ralph Tate at the US Army AVRADCOM⁵. In June 1981, the US Army Procurement Research Office (APRO) at Fort Lee, Virginia was directed to study the applicability of this concept to all weapons systems entering production. The APRO report⁶ submitted to HQ, DARCOM identified the sources of production risks during the transition into production and grouped them into generalized risk categories. APRO developed the theory for TRACE-P and refined the analytical techniques used to quantify and summarize the budgetary impact of risks. Based on the APRO report, HQ, DARCOM refined the methodology by limiting the risks to the eight specific categories shown in Figure 1. Eliminated were risk areas which should be corrected by good management or by other Carlucci initiatives. The methodology was verified by testing the model on the M735 round using historical data. The results obtained from the TRACE-P model approximated the actual costs incurred.

Analysis of M735
Test Results (FY 82 \$ In Millions)

BCE	\$228.82
BCE + Risk	282.50
Actual Cost	289.05

In February 1982, the TRACE-P concept was briefed to and approved by the CG, DARCOM. Subsequently, the DARCOM methodology was briefed to HQDA staff principals as a recommended approach.

TRACE-P CONCEPT

TRACE-P is a budget policy designed to improve the capability of a Project Manager (PM) to minimize the impact of technological risk on his program. TRACE-P provides the PM with a disciplined method of costing for risk as well as providing higher authorities with a scientific money management system. TRACE-P identifies and promotes understanding of the risks involved. TRACE-P aids the PM in coping with those risks by the early and judicious application of funds. These funds provide an early resolution of avoidable risks and a funding solution for unavoidable risks. TRACE-P is used to identify and budget the funds required at the .5 probability level (i.e., 50/50 chance) to accommodate the known technological risks during each of the first three years of significant quantity production. Three distinct actions are required to quantify risk and expand the use of budgeted funds to deal with uncertainty:

1. Identify the funds required for risk, i.e., prepare the TRACE-P estimate. The model used is described below.

2. Budget the funds required for risk. The budgeting process for TRACE-P is outlined below.

3. Manage the program. A separate paper⁷ given at this workshop discusses how the Remotely Piloted Vehicle (RPV) Project Manager (PM) is using TRACE-P to manage his program.

THE MODEL

Seven basic techniques in use to analyze acquisition program risk are described in "Risk Assessment Techniques, A Handbook For Program Management Personnel"⁸. The TRACE-P model can best be described as a Work Breakdown Structure (WBS) simulation. The procedure used to determine the funds required for technological risk during procurement of a weapons systems is as follows:

1. Identify the major subsystems of the weapons system using the WBS. For each subsystem, identify the unfunded technological risks and uncertainties. Each risk is assigned to one of eight risk categories. These categories provide the framework for applying conventional cost estimating techniques to the technological risks and uncertainties.

FIGURE 1

RISK CATEGORIES INCLUDED IN TRACE-P	UNCERTAINTIES EXCLUDED FROM TRACE-P
● THREAT UNCERTAINTY	● QUANTITY CHANGES
● MANAGEMENT	● PERFORMANCE IMPROVEMENTS
● MATERIALS/PURCHASED PARTS	● POOR MANAGEMENT
● FACILITIES/EQUIPMENT	● INADEQUATE FUNDING
● LABOR	● INFLATION
● DESIGN CHANGES	● CIVILIAN PAY ADJUSTMENTS
● PRODUCIBILITY	
● PERFORMANCE	

2. Determine a cost estimate and its distribution for each contingency. Adjustments are made to the data if necessary to assure that the technological risks are stochastically independent.

3. Next, the probability of occurrence of each contingency and its cost distribution are input into the VERT computer program⁹. Using a Monte Carlo technique, the program derives a single cost distribution for all the known contingencies.

4. Apply inflation factors and display results.

5. Include the results in the Baseline Cost Estimate (BCE) and Army Materiel Plan (AMP) by fiscal year.

TRACE-P is an objective, systematic, organized, and credible approach. It identifies specific technological risks and their costs. By including these risks, it provides a better initial cost estimate. TRACE-P will lessen cost growth in the investment phase of weapons systems life cycle.

One other risk assessment technique that shows significant promise for deriving TRACE-P estimates is described in, "Procedures for Modeling TRACE-P Estimates", by Vincent Alfieri¹⁰. This CECOM approach extends the use and application of the contractor's Work Breakdown Structure (WBS) in identifying risk prone areas, and combines the WBS with probabilistic networking techniques to create a data structure which generates risk costs for the designated program. This approach has the potential to consider and integrate a wide

range of inputs. A strong point of Mr. Alfieri's model is the analysis of schedule interactions and the impact of schedule slips on the total cost and schedule. At the present time, the output in terms of technological risk cost has been limited, considering mostly cost estimating uncertainty and schedule slippages. While it is more sophisticated and has greater potential than the current TRACE-P model, it requires more detailed knowledge of the system schedule and imposes data requirements on the contractor. By comparison, the present TRACE-P model is simple, transportable, and demonstratable. Both models produce an audit trail.

BUDGETING

After the TRACE-P estimate is prepared and approved, the TRACE-P value is to be included in the investment portion of all cost and budget estimates. The PM submits the TRACE-P estimate with the BCE for required review and approval. He also enters it in the Army Materiel Plan (AMP). The Major Subordinate Commands (MSC) and HQ, DARGOM must enter the estimated risk cost in their normal programs and budgets within the Planning, Programming, Budgeting and Execution System (PPBES). The TRACE-P estimate becomes part of the budget requirements and must survive budget cuts. The budget process is fraught with difficulties. Figure 2 illustrates the barriers encountered by the initial seven systems.

STATUS OF TRACE-P

In March 1982, the Comptroller, DARGOM assumed responsibility for TRACE-P. A management concept and budgeting methodology were

FIGURE 2

STATUS OF TRACE-P SYSTEMS

SYSTEM	TRACE-P	COMMENTS
KM-833	FY 84 BUDGET POM FOR FY 85, 86	AWAITING CONGRESSIONAL ACTION
RPV	POM FOR FY 86, 87, 88	RESULT OF ASARC
PLI	-	FY 84 \$65M SHORTFALL ABSORBING ALL FY 85 RESERVE
ANIP	-	USOFA CEILING
SINGARS-V	-	CUT IN PROGRAM
STINGER/POST	-	CUT IN PROGRAM
MCS	-	CUT IN PROGRAM

developed. Instructions and guidelines were prepared and published in a DARCOM Letter of Instruction¹¹ on TRACE-P promulgated on 6 October 1982. TRACE-P requirements were computed for the XM-833, the Remotely Piloted Vehicle (RPV), the PERSHING II, the Advanced Helicopter Improvement Program (AHIP), SINGGARS-V, the Maneuver Control System (MSC), and STINGER/POST. A summary is shown in Figure 3. The budget request for the XM-833 projectile was submitted to HQDA on 25 May 1982. The TRACE-P requirements for the remaining six systems were submitted to HQDA on 1 April 1983. HQDA has prepared a draft of a new Army Regulation on TRACE. It outlines the TRACE objectives, policies, responsibilities and procedures. It includes both TRACE-P and TRACE-R (RDTE).

The FY 84 budget contains a request for TRACE-P funds for the XM-833. The Army staff has included TRACE-P funds in the FY 1985-89 POM for the XM-833 (FY 1985-86) and the RPV (FY 1986-88). All TRACE-P fund requests will be reviewed during the Army Materiel Plan (AMP) and post AMP processes prior to the 1985

Office of the Secretary of Defense (OSD) submit for the 1985 budget. HQ, DARCOM's recommendations will be used to determine which weapons systems will get additional TRACE-P funds from the total obligation authority (TOA) of the Army. The total budget request will remain the same. The FY 84 Budget request for the XM-833 has been approved by the House Armed Services Committee (HASC) and the Senate Armed Services Committee (SASC).

The House Appropriations Committee (HAC) believes that there is a need for management reserves to provide the necessary flexibility to address unforeseen circumstances. The Committee is of the opinion that excessive management reserves should be avoided and if additional funds are needed for a particular development effort, specific requests should be submitted to Congress. If it should become necessary to establish management reserves, the Committee expects to be informed of the size of such reserves, the project involved and the reasons for the establishment of such reserves.

FIGURE 3

RESULTS TO DATE

SYSTEM	INITIAL 3 YRS	TRACE-P	TRACE-P AS
	PROCUREMENT		% OF PROC
XM-833	270M	25.3M	9.4%
AHIP	1001	135.2	14.2
RPV	804	111.2	13.7
PERSHING II	1235	63.5	5.2
STINGER/POST	1243	58.4	4.7
MCS	104	11.6	11.2
SINGGARS-V	446	37.6	8.4

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